

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

Issued July 12, 1912.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—CIRCULAR No. 68.
MILTON WHITNEY, Chief of Bureau.

SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XXXIX.

MEADOW.

BY

JAY A. BONSTEEL,
Scientist in Soil Survey.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.

BUREAU OF SOILS.

MILTON WHITNEY, *Chief of Bureau*,
ALBERT G. RICE, *Chief Clerk*.

SCIENTIFIC STAFF.

FRANK K. CAMERON, in charge of Physical and Chemical Investigations.
CURTIS F. MARBUT, in charge of Soil Survey.
OSWALD SCHREINER, in charge of Fertility Investigations.

SOILS OF THE EASTERN UNITED STATES AND THEIR USE.—XXXIX.

MEADOW.

DEFINITION.

The word Meadow, as applied to soil conditions and as used in the soil classification of the Bureau of Soils, designates those low-lying, frequently somewhat swampy areas found along stream courses and tidewater embayments, which are subject to overflow and which are chiefly devoted to pasturage and the production of hay, when used for agricultural purposes, though usually occupied by trees and dense undergrowth when in their natural condition.

Meadow areas, according to this classification, are necessarily variable in texture, since they are among the youngest of soils. They are partially completed soil areas which are subject to frequent accessions of material which may be similar to that already deposited or may differ widely in texture from earlier deposits, depending upon the character of the successive overflows.

The term Meadow as here used possesses the oldest significance of the word. This arises from the fact that before the introduction of the majority of grasses and clovers now used for seeding, the moist, low-lying lands supported a growth of the wild grasses that formed the chief dependence of the early farmers both for grazing and for hay. With the introduction of new grasses and with the spread of grass culture to the uplands, the term was transposed, together with grass growing, and the broader significance of the term was made to include the agricultural use of all land of any character where grass was grown for hay. The older use of the term, which is the definition adopted by the Bureau of Soils, is much more definite and significant for the purposes of soil classification.

Areas of Meadow of various sizes occur along the courses of nearly all of the larger streams of the eastern portion of the United States. Wherever the bottom lands are subject to periodic overflow such soils may be formed. As a result of this condition along all stream courses where soil building is in progress, areas of Meadow have been encountered in 173 different areas, located in 31 different States and aggregating a total of 3,086,829 acres. This vast area constitutes but a small part of the total, and it may be safely estimated that not less than 20,000,000 acres of such soil deposits exist in the eastern part of the country.

CONTRASTS WITH OTHER TYPES.

Not all overflowed stream bottoms are classed as Meadow. There are along many of the larger streams extensive tracts of low-lying lands which are marked by the uniformity of the deposits and by the practical completion of alluvial deposition. Only small portions of these areas are subject to annual overflow and to accretions of new material, or the successive new contributions are so similar in character to the materials already in place that no essential changes in soil texture are accomplished. Such areas of alluvial lands are readily classed into well-known soil series, such as the Wabash series of the stream bottoms of the Central Prairie States, the Yazoo series of the Mississippi River bottoms, or the Miller series of the Red River bottoms in Texas and Louisiana. All such areas are marked by the constancy of the materials already deposited and by the fact that the new materials added are normally of the same character as those already formed. Such groups of alluvial soils have become established and maintain their character through successive periods of inundation.

There are, also, many alluvial bottoms along the larger streams where there is an annual deposition of river sediments of practically the same character from year to year. While these will vary in texture even over small tracts, such areas are classed as Meadow, but at the same time are assigned to definite groups of soil materials such as Meadow, Ocklocknee material; Meadow, Kalmia material; or such other grouping as the characteristic material might warrant. It is recognized that while the separate types of soil have not become established over any particular area, the various materials so closely resemble established series of soils that in due process of time their formation will be completed and they will become definitely assignable to soil groups already established in some other portion of the stream course or drainage region within which alluvial deposition has reached a more advanced stage and the textural characteristics have taken a more definite and permanent form.

Thus, there may be every gradation in stage of completion of such alluvial materials, from the heterogeneous and shifting deposits of meadow areas, through the better established bottom-land soils, recognized as closely allied to definite soil types and series, up to the nearly or quite completed and definite series of well-established alluvial types.

Another set of contrasts distinguishes Meadow from low-lying, somewhat swampy soils of the upland portions of some Coastal Plains sections. Wet soils in these positions would soon become almost indistinguishable from adjacent upland soils, except for the persistence of an unusually large percentage of organic matter. These swampy areas or partially drained upland soils are very distinct from true

Meadow. They are subject to only minor accumulations of new soil-forming material, they have definite textural characteristics over wide areas, and they really constitute poorly drained portions of perfectly definite upland soil types. Thus, a portion of the area of such a soil as the Norfolk silt loam may be locally depressed, subject to the accumulation of seepage waters, and in meadow condition so far as drainage is concerned. Its textural condition, however, is established and sufficiently uniform over considerable areas to constitute it a definite soil type. Such an area may readily be reclaimed by simple drainage. It will change only by the slow accumulation of additional organic matter. The deposition of mineral soil material is reduced to a minimum and consists of a small amount of wash around the margin of the area and of the trifling deposits of wind-blown earth. Such areas are classed with the respective soil types and their present lack of drainage indicated by some convenient symbol.

Meadow differs from the soils of those uplands of the Coastal Plains region which are frequently flat, depressed, and poorly drained, in some very essential characteristics of the arrangement of the different textures of soil material. In the Meadow of the alluvial bottoms there is always a tendency toward the definite arrangements of the different textures of materials which is dependent upon the changing courses and velocities of the streams at times of overflow. There is a banding or semilinear arrangement along the margins of the main streams or along the banks of the temporary channels formed by the flood waters. Such alternations of sand, silt, and clay are caused by the checking of the velocity of the water when the stream channel is abandoned. The coarser particles are deposited almost at once along the stream margins, forming the sandy bars and front lands. At a greater distance the silt and clay are laid down. This gives rise to the characteristic linear arrangement of soils of different texture along the flood plains of the larger streams. In the bottoms of the more torrential streams such arrangement is usually lacking, but there is rapid alternation from sand to silt or clay within short stretches along the stream course. Thus, under all conditions of alluvial deposition, all textures of soil-making material are deposited within narrow geographical limits and often in the most bewildering complexity of arrangement.

The soils of even the lower lying Coastal Plains deposits, which may resemble Meadow in many other respects, are usually lacking in these characteristics. Instead of materials heterogeneously deposited, there are areas of assorted soil textures resulting from the action of waves and of marine currents, giving rise to large areas of different textured soils. There is no characteristic linear arrangement induced by the direction of the course of land streams, but rather an arrangement roughly or plainly associated with the shore line trends and the

direction of marine currents. No additional material is being added to such deposits from the very nature of their origin. They are completed soils and only lack the minor alterations of better established drainage.

Thus not all overflow or swampy lands are mapped as Meadow and only a small proportion of the poorly drained lands of the eastern United States may be so classed.

SURFACE FEATURES AND DRAINAGE.

Areas of Meadow of varying size are found along the banks of almost all streams at some points in their courses. Even streams which have their sources within mountainous regions, where they are active in the erosion of their banks and beds, frequently flow through expanded sections of their courses where more rapid erosion through soft rock or the obstruction formed by some harder stratum holds back the water and causes the temporary deposition of the sediment on its way to the sea. Within the middle courses of the great majority of the longer streams there are areas where the stream spreads out over more level territory or where it has built broad bottoms between the higher, bounding walls of the stream way. These areas are most frequently occupied by broad stretches of "first bottom" which are overflowed during the spring freshets, but are partially drained and productive throughout the balance of the year. These bottoms may be continuous upon both sides of the larger streams or they may exist only upon alternate sides as the stream swings its channel from bank to bank, meandering through a flood plain of low gradient.

The meadowlands always lie below the level of the adjacent uplands. In some cases the landward walls rise to elevations of many feet with a sheer slope. In other instances, where the stream has cut no pronounced channel, the Meadow gradually merges into the better drained upland soil. Every variation between these extremes may exist.

The surface of the meadow deposits is usually nearly level so far as any marked changes in contour or elevation are concerned. There is usually a gentle slope downstream, according to the gradient of its channel, which marks the fact that the surface of the overflow lands is maintained at about a constant elevation above the normal water level of the stream. This is a feature of meadow deposits along streams as distinguished from small areas bordering some of the smaller lakes which possess a nearly flat surface, slightly above the lowest level of the sheet of water. A nearly level surface also marks the meadowlands which have been formed in the delta portions of the stream beds as distinguished from the midstream deposits made before the stream emerges from higher-lying territory to the region of its final soil deposition before entering the sea or inland waters.

The surface of any particular area of Meadow is usually deeply incised by old abandoned channels of the depositing stream which it has occupied temporarily at times of previous overflows. These swales, sloughs, or bayous are frequently steep-sided, crooked trenches which hold a part of the most recent flood waters or remain swampy through the infiltration of seepage waters from other portions of the meadow area or from adjacent uplands. There are also raised ridges and bars of deposits of coarser sediment usually accumulated where the stream has, at some time, left its usual channel and crossed its flood plain. The sudden checking of the velocity of the water causes the deposition of the coarser sediments, carried in suspension, forming banks and bars of gravel, sand, sandy loam, or even of silt. All of these variations in the altitude of any particular area of Meadow range within narrow limits, the general impression created by the surface features being that of low-lying, nearly level land, interrupted by sloughs, swales, or bayous.

In consequence of the constant formation of areas of meadowland along the courses of most of the larger streams of the Eastern States and even along many of their tributaries areas of this type occur at all altitudes from near tide level to more than 4,000 feet. The larger areas and the most numerous instances of meadowland formation undoubtedly occur at elevations less than 1,200 feet, for it is within this zone that the greater part of the landward deposition of the streams takes place. Above that altitude the stream courses are usually too torrential to permit of the accumulation of any large areas of the finer sediments which constitute the greater proportion of the meadowland deposits. The coarser materials temporarily dropped by the flood waters of the mountain streams are so large grained and so rough and even so temporary that they should be classed as River-wash rather than Meadow.

Meadowlands in their natural condition are always poorly drained. This arises from their presence near the normal water level of the parent streams, from the fact that they are periodically subject to overflow by those streams, and that in many instances they accumulate the seepage from adjacent higher lying lands. At a depth ranging from almost the surface to a maximum of a few feet the permanent water table is encountered in the soil or subsoil, even in periods of the greatest drought upon the uplands, and at every overflow both soil and subsoil are again saturated by flood waters. Between inundations, the springs and minor brooks of the upland pour their drainage water into the meadowland areas, providing a constant excess of moisture in such soils.

Except along the immediate banks of the streams the meadowland areas are not usually subject to any severe stream erosion. At every freshet such areas are liable to bodily removal through the cutting of

new channels by the parent stream or through the undermining of the banks in an effort to change the direction of the main channel. The well-known cases of the Mississippi River, where that stream may cut across the neck of a previously formed oxbow and bodily transfer an area of land from one side of the river to the other, is merely typical of the character of erosion to which meadowlands are most subject. There is sometimes minor erosion of portions of the meadow areas crossed by smaller streams, but this action is not usually so pronounced as the deposition of coarse materials, including stone, gravel, sand, and loam, well mixed, in the form of low cones or broad alluvial fans, where these small streams come into full flood at more frequent periods than the main stream. Local storms frequently damage the meadow lands by such deposits, which may replace fertile loam with barren gravel, obliterating any growing crop during the process.

LIMITATIONS IN USE.

By far the greater proportion of the Meadow in its natural condition is covered with a heavy growth of forest. The undergrowth is usually thick, and the luxuriant undergrowth of trailing vines frequently forms an impenetrable jungle. In all of the more northern areas of meadowland hornbeam, ash, red maple, alder, tamarack, white cedar, and a variety of other water-loving trees abound in the more swampy portions, while the black walnut, butternut, elm, and several species of oak are found in the better drained positions. Farther south the same trees are found at the higher altitudes, while near sea level magnolia, bay, cypress, swamp pine, and a great variety of shrubby plants flourish. The native bamboos, locally called switch cane, and the saw palmetto are also abundant.

All of these growths must be cleared from the land before the areas of Meadow may be utilized for any intensive form of agriculture. The cost of the clearing varies with the character and density of the forest and of the undergrowth. In many instances the value of the timber and wood secured will pay for the cost of clearing. In others the return in merchantable product is small. The destruction of the stumps and the underground portions of the trees and shrubbery frequently is more expensive than the removal of the tree growth itself. The cost of clearing meadowlands varies, therefore, from \$5 per acre, when only small amounts of shrubby plants occupy the ground, to \$60 to \$100 per acre where in extreme cases the soil is filled with the roots, buried trunks, and underground stems of a rank vegetation.

Meadowland areas may frequently be utilized without any special attempt at perfecting the drainage. Pastures may become established and may produce an excellent growth of grass by merely clearing away the trees and shrubs and seeding in cultivated grasses. In fact, the flooding of the meadow lands at frequent intervals serves to

add small amounts of fine-grained, fertile sediment and even some organic matter with little injury to the growing grass unless the deposit be too thick to permit it to spring through and make new growth. Areas of meadowland which are above the level of ordinary freshets and are only submerged at long intervals constitute some of the best pasture lands to be found in any part of the country. Such pastures have been known to carry one head of stock to two acres of land, furnishing all of the necessary roughage for six months in the year. Few upland pastures can approach this record of grass production. This ability to maintain a rapidly growing stand of pasture grasses depends largely upon the high content of soil moisture maintained through periods of the year when the upland pastures are badly affected by drought. Hence, for pasturage purposes the complete drainage of the meadowlands is not essential.

In order that meadowlands may be brought into condition to plant the tilled crops, both drainage and diking are frequently necessary. There are very extensive tracts of excellent Meadow located in all sections of the country which merely require the construction of a few rods of dike to prevent the destructive washing of the surface of a tilled field at times of exceptionally high flood to become extremely fertile farm land. Such areas are located where the natural configuration of the land partially protects the area from the floods and where a short bank may be made to connect natural elevations for the exclusion of flood waters. In other cases more elaborate construction is required, and frequently the flood waters of minor tributary streams must be diverted from their usual channel in order that the embanked area may be not be flooded from the upland, even after proper levees have been constructed along the major stream. The problem becomes unusually complicated when a minor stream flows through the center of an area to join the chief stream at its farther border. In such cases embankments are required along the margins of both streams. Thus the problem of protecting areas of meadowland from inundation becomes one of the particular area rather than a general one for all classes of meadowland.

The construction of embankments for the exclusion of flood waters should usually be accompanied by some provision for drawing off the seepage waters of the area inclosed and for reducing the water table under the land to be reclaimed. The construction of the dikes should be coincident with the excavation of ditches along their inner walls into which the internal drainage of the project may be led. Except for a few main-line ditches, which may be left open, it is usually more satisfactory to complete the drainage by means of tile underdrains. The chief advantage of this method of drainage lies in the fact that the reclaimed area is not cut into small tracts by a number of open ditches, but is left in a larger tract for greater convenience in tillage

and cropping. The arrangement of flood gates to allow the exit of drainage water without permitting the entrance of stream waters is also one of the important points in arranging for the drainage and protection of reclaimed areas of Meadow. This is usually accomplished by inserting in the embankment valve gates which open outward by the pressure of drainage waters when the stream is at low levels and automatically close by the inward pressure whenever the stream rises. Extensive use has been made of these methods of reclamation along the Atlantic coast and upon some of the larger riverside areas of Meadow.

The soils of the Meadow, as already stated, vary extremely in texture, composition, and physical condition of compactness. In consequence, the inherent properties are extremely variable when the planting of tilled crops is considered. In addition the climatic surroundings are diversified in the extreme. Consequently, no general recommendations as to specific crop adaptations may be made beyond the statement that such soils are best suited to those crops which thrive under moist soil and subsoil conditions. Universally the grasses meet this condition. Other special crops will be discussed elsewhere.

DIFFERENT CLASSES OF MEADOWLANDS.

The soils of the meadow areas are so extremely diverse that scarcely any single area consists entirely of one class of soil material. The broader and larger areas are frequently found to contain material ranging from coarse sand and gravel, near to present or abandoned stream channels, to the finest silts and clays in regions more remote from the first effects of overflow or in depressed positions where the final flood waters are collected and only deposit their load of sediment through long periods of settling assisted by the final evaporation of the water. The texture of different areas of Meadow and even of different portions of the same area may, therefore, vary from bowlders, coarse gravel, and sand to the finest grained silts and clay.

One of the characteristic features of the Meadow is that new accessions of material are being received continually in the majority of areas, and, while it may happen that the new material resembles the old in all essential respects as a soil, this is not at all certain to be the case, and any particular acre of land may be covered one year by a heavy silty soil and after a succeeding flood with a deposit of sand or gravel. Thus, the constancy of the soil is not at all assured in even a single area.

The quantity of organic matter in the better protected areas of Meadow is frequently so great as to render the surface soil mucky. This is particularly the case where Meadow has been formed along the margins of tidewater or the borders of small estuarine streams.

In such areas the accumulations of dead and partially decayed vegetation form soils which contain only a small proportion of mineral matter. Similarly in heavily wooded areas, bordering streams flowing through the upland, the water of the overflows is frequently so checked that large amounts of vegetable matter may be retained and mingled with the contributions of fresh mineral sediments. In such positions soils high in organic matter content are formed.

In general, it may be said that the broader areas of Meadow, which are not subject to torrential overflow, but merely to submergence by gently rising waters, will usually be found to contain larger quantities of organic matter in the surface soils than those areas which are suddenly inundated by rapidly flowing currents. In the latter cases the organic matter which has accumulated is swept away, little new material other than the coarser mineral matter is added, and the resulting soil is not characteristically well filled with humus. All gradations between these extremes may be met, even within restricted areas.

Through some portions of the Piedmont Plateau the meadow soils are characteristic of that section and differ materially from soils similarly deposited in other regions. The main streams which flow through the plateau have their major tributaries within the Appalachian Mountains or their foothills, and the gradient of the stream beds in their upper courses is very steep. They flow through a section marked by the deep weathering of the rocks and a consequently friable and incoherent condition of the surface soils and subsoils. Over extended upland areas along the headwaters of these streams and the courses of their Piedmont tributaries the granite and other crystalline rocks have become disintegrated to a depth of 20 to 40 feet and remain as a loose aggregate of mineral matter, thinly covered by true soil. The sudden torrential rains of winter and early spring frequently remove vast quantities of this disintegrated rock, which is further comminuted by its grinding passage down the stream beds. Such a sand-laden torrent may suddenly cover broad, fertile lowlands in the middle course of the stream with a deposit of white granitic sand having a depth of 2 to 15 feet. Destruction is doubly accomplished in such instances through the removal of soil-forming material from the eroded uplands and its deposition upon the fertile bottom lands. It is sparsely mingled with organic matter in its new position; it is completely washed of all fine earth suitable for the immediate sustenance of the economic forms of plant life; it covers and destroys growing crops; and it obliterates the fertile, tillable land whose surface it covers. This form of destructive deposition is only a form of damage resulting from the destruction of forest cover at a far distant point. A stream originating in one State may by its destructive inundations destroy farm lands in another.

USES OF MEADOWLANDS.

The Northeastern States.—The meadowland soils of the Northeastern States are little used at present except for pasturage, and considerable areas are covered with timber. Some swamp hay is cut. Only in a few instances have drainage operations been undertaken for the reclamation of such areas. Some small tracts, occupied by mucky surface soils, may be used to advantage for the production of celery, onions, cabbages, and lettuce. Where a tract of Meadow consists of 12 to 24 inches of muck overlying the subsoil, and where the local demand or the means of transportation to market is good any outlay for drainage will be amply repaid in yields of such special crops as cabbages, onions, and celery. In other instances the straightening of stream courses and a little supplementary drainage would serve to utilize the meadowlands for the growing of excellent crops of hay, particularly timothy and redtop.

A special use is made of certain extremely swampy areas of Meadow in central New York, where many tons of rushes are cut, dried, and sold for use in the weaving of the bottoms and backs of chairs.

The dried rushes sell for \$20 to \$25 a ton. All of the labor of cutting, curing, and transporting the rushes must be done by hand, since the land is too soft and swampy to permit the use of horses. It is probable that if the lands could be partially drained through the use of open ditches, the level of the water could be so controlled as to be sufficiently high to meet the requirements of rush growing during the season and drained off just before the time of harvest, so that the land would become stable enough to permit of the use of horsepower machinery in the cutting and hauling of the rushes. At present it takes one man a week to cut and market about 1 ton of rushes.

The Middle Atlantic States.—In New Jersey, Pennsylvania, and Maryland a considerably greater use of the meadow areas is made. Nearly 30,000 acres of seashore meadows have been diked, drained, and reclaimed along the Delaware River in southwestern New Jersey. These areas were originally salt meadows, above which the tide rose, receding and rendering the growth of coarse grasses possible. These salt meadows constituted one of the chief dependencies of the pioneer settlers for both hay and pasturage. Many of them were familiar with such uses of meadowlands in the European countries from which they came and naturally valued the same kinds of grass lands in their new homes. Over 15,000 acres of such meadowlands have been diked and drained in Salem County, N. J., while other large tracts have been utilized in Gloucester and other counties of the southern portion of the State. Cooperative companies are organized for the construction of the dikes necessary to shut out the tide-waters. Along exposed stretches these earth banks are protected

by a stone facing. Automatic gates are provided which permit the egress of the storm waters, but shut the tidewater from the embanked areas. Broad ditches accumulate the waters drained from the areas and from adjacent uplands and the flow of streams is carried through the meadows in dredged channels, frequently constituting the main drainage way of the reclaimed area.

The growing of grass for hay or pasturage is the chief utilization of these embanked areas. It is a strong indication of the value of these lands that such extensive works can be undertaken for the protection of lands devoted to no more intensive uses than hay production and pasturage.

Small local areas, near to market, have been used in southwestern New Jersey for the cultivation of corn, tomatoes, cabbage, and other garden vegetables.

In southeastern Pennsylvania the areas of Meadow along the stream bottoms were highly prized for the growing of grass in the early days of settlement. Wherever possible the new farm was made to include such areas, and small dams were constructed to spread the waters of the stream over even larger areas of the bottoms. In some cases the courses of streams were diverted to furnish additional supplies of water for the Meadow and to irrigate uplands for the growing of grass. Many of the older deeds to farm lands set forth the particular days of the week upon which the owner of the property is entitled to the use of stream water for the flooding of Meadow. Some use is still made of this Meadow and of the stream water for the formation of irrigated upland mowing lands in this region, despite the fact that the annual precipitation amounts to nearly 45 inches.

A small proportion of the Meadow in other portions of the State has been used for other crops than grass. Corn is most usually grown among the field crops. Areas especially well located with regard to market have also been used for cabbage.

Large areas of Meadow are found in the lower-lying portions of the tide-water section of Maryland. These lands in the majority of instances lie at elevations of 2 feet to 25 feet above tide level and consist of a compact, silty soil, are nearly level, and always poorly drained. In its natural condition this land is covered with a dense growth of sweet gum, several varieties of oak, chiefly white oak in the original forests, and birch, dogwood, and other undergrowth. Considerable areas have been cleared and used for the growing of wheat and corn. Winter wheat makes a very good growth and yields from 5 to 20 bushels per acre. Corn is not so well suited to the broad foreland areas and is liable to become severely affected by the droughts of midsummer, since the poorly drained land bakes to a solid mass at the surface. The yields range from 15 bushels to 35 bushels per acre, the latter yields being secured where the drainage

is the best. A considerable quantity of coarse hay is cut and pasture is obtained from both the cleared and uncleared areas.

The Meadow along some of the stream bottoms of the higher-lying sections of the State constitutes excellent corn land.

The South Atlantic States.—Throughout Virginia, the Carolinas, Georgia, and northern Florida are very extensive areas of Meadow, lying within the low coastal sections. These are almost universally covered with a dense growth of timber, undergrowth, and vines, while only small areas have been cleared for farming.

It is within the narrow stream valleys of the Piedmont section that the most important areas of Meadow have been utilized for agriculture within this general region. The broad bottoms along the lower courses of the larger streams heading in the Appalachian Mountain system and flowing across the Piedmont are among the choicest corn lands of the Atlantic seaboard States. They have been tilled from the earliest occupation of the region and have always produced large crops of corn. Some small patches of tobacco are also grown, while hay and pasture constitute the other crop uses of the land. In the more southern States some cotton is planted upon these river bottom soils. It makes a large growth of the plant and matures rather late in the season. Heavy yields are reported from well-drained areas of the bottoms which have been protected from destructive overflow.

In later years there has been a growing uncertainty of crop production upon these soils from the fact that the overflows are more sudden and destructive, following the deforestation of large areas of mountain land along the headwaters of the streams. Not only does the flood water rush across the fields of growing corn or cotton, but each deluge leaves behind thick deposits of almost pure sand, which bury the fertile top soil of the field to a depth of 2 to 6 feet or more and destroy the cropping capacity of the land.

Along the larger streams which flow through the limestone valley portions of Maryland, Virginia, West Virginia, Kentucky, and Tennessee there are numerous small individual areas of the best class of meadow soils. These sediments consist largely of finely ground limestone rock, mixed with other mineral matter, and a large percentage of rich humus. Some of the largest corn yields reported from the Eastern States have been obtained from these meadow soils. A yield of 80 bushels per acre is not unusual, while yields in excess of 100 bushels have been reported. Cowpeas, rye as a cover crop, wheat, and grass are also grown.

The Gulf States.—The most extensive areas of alluvial Meadow to be found in the country are encountered along the lower courses of the larger rivers flowing into the Gulf of Mexico. These streams are almost universally bordered by broad but interrupted stretches of

low, alluvial lands which are as yet scarcely built above the level of even moderate freshets. Many of the streams are bordered not only by low-level first bottom terraces, but also possess at least one higher bench, subject to overflow at extreme stages of high water. In a few instances a third bench exists which is occasionally submerged but is usually considered as a part of the upland.

Probably 95 per cent of this rich alluvial soil still remains in a dense growth of forest, and rarely has any effort been made to reclaim these lands by the construction of levees, except along the Mississippi River and its navigable tributaries. As a result, some of the most productive soils of the Gulf States still remain covered by jungle and totally unappropriated for any agricultural uses.

The soils within the boundaries of these southern meadow areas range from stiff black clays, derived from the black lands of the adjacent upland prairies, through gray silty clays and loams derived from the silty loess of the bluff lands along the eastern boundary of the Mississippi River drainage way, to the sandy loams and sands, reworked from the sandy uplands of a greater part of the Coastal Plains. This wide variation in the texture of the different soils of the meadowlands gives rise to a considerable variation in the uses to which reclaimed areas may be profitably put. Upon the areas of the heavy black clay soils alfalfa may be grown where the land has been protected from overflow and the water table reduced to a level of 3 feet below the surface of the land. These soils are usually calcareous, well filled with organic matter, granular and friable when plowed in the right condition as regards moisture. Corn is also well suited to these meadows. With cotton there is a tendency toward long-continued growth of the plant, with consequent late fruiting, which causes only a small proportion of the bolls to mature before the frosts of autumn. This is a decided disadvantage, especially in localities where the cotton boll weevil has made its appearance, since success with this crop is largely dependent upon the planting of early maturing varieties. Considerable areas of these heavier meadow soils are occupied by pastures of Bermuda grass and lespedeza. Lands formerly tilled have sometimes been given over to these forage crops upon the appearance of the boll weevil and now furnish pastureage or hay rather than cotton.

The gray silty clays or silty loams of the meadow areas are sparingly planted to cotton. Usually they are given over to corn in the Gulf States, since they maintain a sufficient supply of moisture to carry the crop through the droughts of midsummer and give larger yields of corn than the upland soils. In many instances the corn yield upon meadow areas is double that of the adjacent upland soils. Sorghum and ribbon cane are also grown upon these and the more sandy of the meadow soils.

It is probable that larger areas of the sandy soils of the southern bottom lands are used for agricultural purposes than of any of the heavier lands. Such soils are usually more readily cleared; they lie at higher elevations in many cases; they are easily broken and tilled with the light-weight farm equipment which prevails in the section; and they are sufficiently retentive of moisture to bring cotton to a reasonably early maturity with fair yields, while the heavier soils give later crops and lower yields. For these reasons the sandy bottoms are more generally utilized. Cotton, corn, sweet potatoes, melons, okra, sorghum, ribbon cane, Bermuda grass, lespedeza, and even white clover are grown upon these areas of bottom land. The yields secured depend upon the individual efficiency of the tillage rather than upon any marked differences in the inherent soil characteristics. Corn produces from 15 to 45 bushels per acre, cotton yields from one-fourth bale to three-fourths bale per acre, and cane sirup ranges from 200 gallons to 500 gallons per acre. Good crops of hay may be cut, and the meadow pastures furnish excellent grazing through a longer period of the year than any other grazing lands in the Gulf States.

There remain thousands of acres of such soils awaiting reclamation for agricultural uses, and one of the most valuable southern land resources lies within the areas of these fertile, drought-resistant bottom lands.

The South Central States.—No very extensive areas of Meadow have been encountered in the South Central States. This arises from the fact that the relief of this section is sufficient to permit of the cutting of deeply entrenched stream channels by all of the larger streams. Some of these are gorgelike and lack arable bottoms. Others are bordered by distinct terraces, occupied by definite series and types of soils that do not fall within the meadow classification. Small stretches of Meadow occur along the Ohio River and its principal tributaries from the south. These are made up of mingled sediments from the sandstone, shale, and limestone rocks of the upland and are usually fertile corn and grass soils where naturally or artificially protected from destructive overflow. Yields of corn reach the high average of 40 to 60 bushels per acre, while grass cuts from 1 to 2 tons, and the pasturage is excellent even upon less well-protected areas.

The North Central States.—Meadow areas of large extent are lacking over the greater part of the North Central States. The soils of the river margins are frequently distributed as raised terraces marked by definite types and series. There are within the narrow depressions occupied by some of the minor streams local stretches of true Meadow that are usually mucky, poorly drained, and used for pasturage or the cutting of wild-grass hay. Such areas when the stream channels are straightened or when tile drainage is installed approach closely

the upland soils with which they are associated, differing chiefly in a somewhat higher organic-matter content and somewhat more moist condition within the subsoil. Wild-grass hay is the chief product of the meadow areas of these regions when they are in their natural condition. Yields of 1 to 2 tons per acre are secured in Wisconsin, Minnesota, and the Dakotas.

The reclamation of many such areas through proper drainage has been one of the marked steps of agricultural progress within the last generation within the North Central States and areas formerly valuable for their contributions of wild hay are now among the most fertile corn-growing soils. Moreover, with drainage and protection from overflow, these soils have been used for the growing of the more valuable grasses, clover, and alfalfa, and even for the seeding of wheat and oats. Small areas, well located with regard to market or to transportation, have been used for the growing of cabbage, onions, celery, and other market-garden crops. These areas typify the course which should be pursued with respect to thousands of acres of Meadow in the more northern latitudes.

SUMMARY.

Meadow, in the classification of the soil survey, is a term used to designate low-lying lands along streams which are subject to periodic overflow but are not necessarily swampy at all times of the year. Since such lands were first used for the growing of hay and the pasturing of animals, the first meaning of "meadow" was that of such soils and conditions. The word is also used in a broader sense to indicate any land where grass is cut for hay. This is a later use, arising from the spread of grass production from the overflow lands to uplands in general.

Meadow occurs at any portion of a stream where the overflow waters become checked in their velocity and are thus enabled to deposit their load of sediment. Meadow soils are thus in the process of formation at the present time. In consequence there may be no fixed characteristic soil in any particular area of Meadow, as succeeding freshets may bury older deposits of silt or clay under new loads of sand or gravel. Meadow areas are thus changeable in their soil texture from year to year.

Because of the method by which Meadow is formed, small areas of diversified soil materials constitute different portions of the same area of stream bottom. This results in a wide variation in conditions, deposits ranging from sand and coarse gravel to sandy loams, loams, and even stiff clays. In some areas which are not subject to erosive overflow accumulations of mucky surface soil may take place.

In their natural condition all meadow areas are depressed below surrounding uplands, subject to overflow, and in need of artificial

drainage. They may be covered with a heavy growth of forest trees, interspersed by thick undergrowth or sparsely forested and the glades covered with grass. Many of the meadow areas in the prairie States were covered with a rank growth of wild grasses before being drained and reclaimed. Other areas in the vicinity of tidewater were formed at or near sea level and were originally covered by rushes and water-loving grasses.

Protection from overflow is always essential to the utilization of meadow areas. This may take the form of levees along inland streams, of dikes along stretches of tidewater meadows, or of the strengthening and completion of natural barriers to flood waters.

Drainage is also essential to any of the more intensive forms of use of the meadow soils. This is usually accomplished through the digging of large, open, main ditches into which the land drainage empties through tile underdrains. Floodgates are frequently required, closing automatically to shut out the rising river waters or the high tides.

The cost of clearing meadow areas for cultivation is one of the chief items of expense in their reclamation and varies widely under different circumstances of vegetation. The sloughs and swales of the North Central States are practically reclaimed when diked and drained. The tidewater meadows are usually free from all of the larger forms of plant growth. Thousands of acres of Meadow along the lower courses of the chief rivers of the eastern United States are naturally heavily timbered and covered with a secondary jungle of undergrowth and vines. Such lands may require the expenditure of \$50 to \$100 per acre for their clearing and stumping off. In a few cases the timber growth is sufficiently valuable to repay such cost.

The crop adaptations of the meadow soils are extremely variable because of the wide differences in texture possessed by these soils and the divergent climatic conditions under which the different areas occur. In the more northern States the production of grass for mowing or pasturage is the chief use made of the cleared meadow areas. Corn, oats, and market-garden crops are also produced. In the Piedmont Plateau region Meadow constitutes some of the best corn soils of the region and areas not subject to destructive inundation produce corn yields of 40 to 60 bushels per acre.

In all of the more southern areas, where Meadow is extensively developed along the larger streams flowing into the Gulf of Mexico, small areas are cleared and used for cotton, corn, sugar cane, Bermuda grass, lespedeza, and a variety of vegetables. Cotton requires too long a season to reach maturity upon some of the moist bottom lands and, under the conditions of the invasion of the cotton-boll weevil, the meadow areas are coming to be devoted more and more to corn and grass production.

Small areas of Meadow exist within the Central and North Central States and are used for the growing of grass and corn. Thousands of acres of such soils have been reclaimed and now constitute rich corn and wheat lands. They can not be classed as Meadow in their present protected and drained condition.

Over 3,000,000 acres of Meadow have been mapped during the progress of the soil survey and it is estimated that 20,000,000 acres of this class of material exist in the eastern portion of the United States. In many instances these lands are the most fertile of the unappropriated lands of the section and thus constitute a considerable reserve of excellent soil which may be reclaimed when economic conditions will justify the outlay required for their diking, drainage, and clearing.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., April 24, 1912.

APPENDIX.

The following table shows the extent of Meadow in the areas which have been surveyed to this time. In the first column is stated the particular soil survey in which the area was encountered, in the second column the extent in acres, and in the third column the volume of the Field Operations of the Bureau of Soils in which the report upon the area may be found. Those desiring a detailed description of the soils and of the general conditions which surround them in any particular area, may consult these volumes in almost any public library.

Areas of Meadow encountered in the Soil Survey.

Survey.	Area of soil.	Date. ¹	Survey.	Area o soil.	Date ¹
Alabama:			Kentucky:		
Autauga County.....	23,488	1908	Mason County.....	832	1903
Baldwin County.....	32,128	1909	Louisiana:		
Bibb County.....	4,544	1908	Bienville Parish.....	90,048	1908
Blount County.....	9,216	1905	Caddo Parish.....	45,888	1906
Butler County.....	37,248	1907	Concordia Parish.....	24,960	1910
Coffee County.....	9,984	1909	De Soto Parish.....	72,448	1904
Dale County.....	12,352	1910	East Baton Rouge Parish.....	17,408	1905
Dallas County.....	11,584	1905	Iberia Parish.....	192	1911
Etowah County.....	7,296	1908	Lineo In Parish.....	46,208	1909
Huntsville area.....	42,240	1903	Ouachita Parish.....	13,440	1903
Jackson County.....	11,136	1911	Tangipahoa Parish.....	55,936	1905
Lee County.....	9,920	1906	Winn Parish.....	111,168	1907
Macon County.....	19,328	1904	Maryland:		
Montgomery County.....	10,944	1905	Anne Arundel County.....	19,648	1909
Perry County.....	53,496	1902	Calvert County.....	15,500	1900
Pike County.....	59,008	1910	Easton area.....	20,480	1907
Randolph County.....	2,496	1911	Harford County.....	4,440	1901
Sumter County.....	21,952	1904	Kent County.....	49,230	1900
Tallapoosa County.....	28,800	1909	Prince Georges County.....	30,870	1901
Tuscaloosa County.....	36,096	1911	St. Marys County.....	54,200	1900
Arkansas:			Michigan:		
Fayetteville area.....	1,536	1906	Allegan County.....	15,510	1901
Delaware:			Alma area.....	6,592	1904
Dover area.....	4,096	1903	Cass County.....	3,648	1906
Florida:			Owosso area.....	2,688	1904
Escambia County.....	45,632	1906	Oxford area.....	4,992	1905
Gadsden County.....	52,224	1903	Pontiac area.....	4,032	1903
Jefferson County.....	14,080	1907	Saginaw area.....	16,000	1904
Leon County.....	25,216	1905	Minnesota:		
Georgia:			Blue Earth County.....	19,264	1906
Bainbridge area.....	6,656	1904	Carlton area.....	5,248	1905
Cobb County.....	30,280	1901	Marshall area.....	448	1903
Covington area.....	16,416	1901	Rice County.....	40,832	1909
Dodge County.....	19,584	1904	Mississippi:		
Fort Valley area.....	4,800	1903	Biloxi area.....	17,600	1904
Franklin County.....	5,376	1909	Crystal Springs area.....	3,328	1905
Grady County.....	31,360	1908	Forrest County.....	12,416	1911
Hancock County.....	15,104	1909	Holmes County.....	29,760	1908
Spalding County.....	9,472	1905	Jackson County.....	60,736	1904
Sumter County.....	11,264	1910	Lauderdale County.....	18,112	1911
Thomas County.....	29,120	1908	Lowndes County.....	6,912	1911
Waycross area.....	10,624	1906	McNeill area.....	6,976	1903
Illinois:			Montgomery County.....	21,184	1906
Winnebago County.....	44,800	1903	Smedes area.....	17,408	1902
Indiana:			Yazoo area.....	4,760	1901
Allen County.....	6,208	1908	Missouri:		
Madison County.....	10,816	1903	Atchison County.....	4,352	1909
Marshall County.....	6,784	1904	Saline County.....	3,584	1904
Iowa:			Shelby County.....	36,416	1903
Cerro Gordo County.....	3,456	1903	New Hampshire:		
Dubuque area.....	4,160	1902	Merrimack County.....	14,848	1906
Story County.....	18,048	1903	Nashua area.....	18,368	1909

¹ Year of publication, Field Operations.

Areas of Meadow encountered in the Soil Survey—Continued.

Survey.	Area of soil.	Date. ¹	Survey.	Area of soil.	Date. ¹
New Jersey:					
Salem area.....	52,250	1901	South Carolina:		
Trenton area.....	44,800	1902	Abbeville area.....	6,336	1902
New York:			Anderson County.....	19,904	1909
Auburn area.....	8,000	1904	Campobello area.....	8,691	1903
Bigflats area.....	1,920	1902	Cherokee County.....	6,208	1905
Dutchess County.....	24,192	1907	Lancaster County.....	11,392	1904
Long Island area.....	16,768	1903	Saluda County.....	9,408	1909
Lyons area.....	33,024	1902	York County.....	14,720	1905
Niagara County.....	1,216	1906	Tennessee:		
Tompkins County.....	8,128	1905	Greeneville area.....	17,216	1904
Westfield area ²	6,650	1901	Overton County.....	4,672	1908
North Carolina:			Texas:		
Alamance County.....	15,970	1901	Anderson County.....	56,640	1904
Asheville area.....	7,808	1903	Bastrop County.....	10,880	1907
Cabarrus County.....	4,736	1910	Camp County.....	19,776	1908
Cary area.....	3,180	1901	Franklin County.....	12,480	1908
Caswell County.....	13,632	1908	Grayson County.....	28,736	1909
Gaston County.....	12,032	1909	Henderson County.....	47,424	1906
Granville County.....	14,784	1910	Houston County.....	52,864	1905
Henderson County.....	1,024	1907	Jacksonville area.....	2,624	1903
Hickory area.....	23,872	1902	Lee County.....	13,760	1905
Mecklenburg County.....	16,320	1910	Lufkin area.....	4,288	1903
Mount Mitchell area.....	6,976	1902	Morris County.....	13,504	1909
Raleigh to Newbern area.....	6,330	1900	Nacogdoches area.....	5,056	1903
Statesville area.....	18,466	1901	Robertson County.....	10,560	1907
North Dakota:			Titus County.....	18,432	1909
Carrington area.....	16,064	1905	Willis area.....	1,510	1901
Jamestown area.....	4,992	1903	Wilson County.....	4,544	1907
Ransom County.....	12,416	1906	Woodville area.....	5,568	1903
Richland County.....	28,672	1908	Vermont:		
Ohio:			Vergennes area.....	3,968	1904
Ashtabula area.....	12,160	1903	Virginia:		
Cleveland area.....	704	1905	Albemarle area.....	40,640	1902
Montgomery County.....	7,200	1900	Appomattox County.....	5,760	1904
Oklahoma:			Bedford area.....	3,530	1901
Tishomingo area.....	3,904	1906	Campbell County.....	25,280	1909
Pennsylvania:			Chesterfield County.....	25,088	1906
Adams County.....	3,648	1904	Hanover County.....	15,552	1905
Berks County.....	24,640	1909	Leesburg area.....	18,048	1903
Center County.....	5,248	1908	Louisa County.....	11,520	1905
Chester County.....	20,480	1905	Montgomery County.....	4,800	1907
Johnstown area.....	9,792	1907	Prince Edward area.....	19,830	1901
Lancaster area.....	6,000	1900	West Virginia:		
Lebanon area.....	4,780	1901	Upshur County.....	11,008	1905
Lock Haven area.....	896	1903	Wisconsin:		
Montgomery County.....	3,328	1905	Iowa County.....	8,000	1910
Rhode Island:			Janesville area.....	18,112	1902
State.....	1,920	1904	Racine County.....	11,328	1906
			Viroqua area.....	7,104	1903
			Waukesha County.....	1,728	1910

¹ Year of publication, Field Operations.² Mapped as Meadow and Cassadaga sand.

ADDITIONAL COPIES of this publication
may be procured from the SUPERINTEND-
ENT OF DOCUMENTS, Government Printing
Office, Washington, D. C., at 5 cents per copy











